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Progress Report/Final Report- Agreement INT-96110-RJVA
(study continued under Lynx Ecology II, RMRS-99620-RJVA)

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INTRODUCTION

The U.S. Fish and Wildlife Service's listing of Canada lynx (*Lynx canadensis)* as "Threatened" under the Endangered Species Act is a major issue affecting National Forests across the west. The Federal Register (vol. 65. 16052-16086) states that human alteration of forest abundance, composition, and connectivity is the most influential factor affecting lynx habitat. However, our understanding of habitat-use patterns of lynx is very limited, including how these activities truly impact populations. Only six studies have researched the ecology of southern lynx populations (Koehler et al. 1979, Mech 1980, Brainerd 1985, Smith 1984, Brittell et al. 1989, Koehler 1990), two of which focused primarily on bobcats (Smith 1984, Brainerd 1985). Thus, managers are in the difficult position of having to prescribe management recommendations based on limited data.

The Rocky Mountain Research Station, in cooperation with the University of Montana, is studying the ecology of lynx near Seeley Lake, MT. Primary funding is provided by the Rocky Mountain Research Station, with additional major contributions from Plum Creek Timber Company and the Bureau of Land Management. Our primary research goal is to determine habitat-use patterns of lynx at multiple spatial scales, including how habitat structure and prey abundance affect habitat selection. Habitat-use data are limited for northern and southern lynx populations even though this information is badly needed before prescribing management actions. For example, we do not understand how changes in tree density, understory cover, patch size, or canopy closure impact habitat suitability. Although understanding habitat relationships is essential, we also need to understand demography, dispersal, and how habitat alterations may impact habitat connectivity. To address these broad-scale issues, we need to study lynx ecology across a north-south gradient from northern Montana to the Greater Yellowstone Ecosystem (GYE). Thus, as we begin shifting our focus on broad-scale issues, it is increasingly important that we study a representative sample of lynx that is geographically well distributed.

In this report, we provide an interim update of our lynx research. These data are preliminary and may change with additional information. Thus, the information

discussed in this document is for project reporting and planning, and should be used accordingly.

OBJECTIVES

We are addressing the following study objectives:

1) Describe how seasonal movements and habitat selection of lynx are affected by vegetation structure, forest management, human disturbance, and prey abundance within forest stands;

2) Determine habitat selection at kills, daybeds, and den sites in terms of vegetation structure, composition, and pattern;

3) Describe winter food habits and relate them to patterns of prey abundance;

4) Determine how landscape composition (presence and number of habitat patch types), configuration (patch distribution and spatial arrangement), and fragmentation impact habitat selection among populations in the Rocky Mountains;

5) Determine population vital rates including age-specific survival, litter size, recruitment, and mortality patterns to the extent possible given a study of limited duration and sample size;

6) Describe the extent and timing of lynx dispersal, including crossings of natural and anthropogenic barriers.

STUDY AREA

Our primary study area is located in the Clearwater River drainage, near the town of Seeley Lake, Montana. The area is approximately 1800 km^2 in size, and extends east to west from the Swan Range to the Mission Mountains, and north to south from Lindbergh Lake to Salmon Lake. Lynx harvests (1977-94) and track surveys suggest this area may support the highest density of lynx in Montana (Brian Giddings pers. comm.). The Bob Marshall and Mission Mountain Wilderness areas flank the study area to the east and west, respectively. The study area includes state, federal and private lands that

support intensive commercial forestry. Associated with intensive forestry is an extensive road system that extends throughout the study area. The combination of a well-developed road system, coupled with a deep snow-pack, attracts private and commercial snowmobile operators during winter months.

Elevations at Seeley Lake range from approximately 1,200 to 2,100 m. The dry-forest types at lower elevations are dominated by Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and ponderosa pine (*Pinus ponderosa*) on south to west aspects. Most stands are composed of mixed forest types, although pure stands of Douglas-fir are present (U. S. Forest Service 1997). Low-elevation forests are often park-like, but dense stands occur where fire has been absent.

Fire is the primary natural disturbance and occurs at frequent intervals (average = 42 years, Fischer and Bradley 1987). Based on 1930 photos, forest patches with moderately open overstories were several hundred to thousands of hectares in size (U. S. Forest Service 1997). Timber harvest and fire suppression have shifted the open mature forests that were once most prevalent on low-elevation sites, to forests of small-diameter, densely stocked stands.

Forests at mid-elevations are dominated by cool-moist to dry conifer types. Dominant tree species include seral Douglas-fir, western larch, and lodgepole pine in mixed to single-species forest stands. Low frequency, stand replacing fires create even-aged stands that form a mosaic of early seral to old-growth forests (Fischer and Bradley 1987).

Upper elevation forests are mostly subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), and Engelmann spruce (*Picea engelmannii*) with lesser components of lodgepole pine, Douglas-fir, and western larch. Subalpine forests are multi-storied and multi-aged, often with a dense shrub understory. Fire disturbances are infrequent and vary from small spot to large stand-replacement fires depending on climatic conditions. Riparian vegetation varies from riparian grasses and sedges to shrub communities composed of dogwood (*Cornus spp.*), willow (*Salix spp.*), alder (*Alnus spp.*) and mixed conifer forests. Forested riparian areas are primarily subalpine fir, Engelmann spruce, Douglas-fir, and black cottonwood (*Populus trichocarpa*).

STUDY CHRONOLOGY

We began fieldwork at Seeley Lake during January 1998. During this first winter, our primary focus was to trap and radio collar an adequate sample of lynx. We also tested field methods, identified new research objectives, and gained preliminary insights regarding the distribution and movement of lynx within the study area. During our first summer (April- August, 1998), we needed to develop telemetry methods for aerial and ground-based telemetry before we could study summer habitat use. This work included assessing the accuracy of aerial and ground-based telemetry to determine the appropriate scale for habitat-use evaluations. We then began efforts to relocate lynx throughout the day to study summer habitat-use patterns, thus we had little time for habitat sampling.

During our second winter (December 1998 through March 1999), we continued trapping and began sampling winter habitat use. We trapped additional animals and quantified habitat characteristics along lynx back-tracks. During our second summer (May – August, 1999), we intensively monitored the denning behavior of all collared females and quantified habitat characteristics at lynx relocation points, including relocations from the previous summer. We also experimented with using short-duration (4 day) mark-recapture trapping as a means of estimating the density of snowshoe hares (*Lepus americanus*) at summer relocation points. Our goal was to rapidly assess prey abundance at summer-use areas so that we could determine how prey abundance affected habitat selection. However, we found that estimated hare densities from grids that were trapped for only four days were highly variable, and did not provide reliable estimates of prey density.

During our third winter (Dec. 1999-March 2000), we expanded trapping to include Shafer Meadows in the Great Bear Wilderness and on Forest Service lands near Lincoln, MT. Expanding our study area allowed us to consider habitat-use patterns across broader environmental gradients. We also continued winter backtrack studies. During the summer (May – August 2000), we continued radio-tracking lynx throughout the day (4:00 – 22:00), and we quantified habitat characteristics at all relocation points. Based on our hare trapping results from the previous summer, we discontinued trapping hares at relocation points in favor of using indices of prey abundance.

Indices need verification before they can be used to estimate the relative abundance of prey (Pollock et al. 1990). We used burrow counts to index ground squirrel abundance and pellet counts to index hares. To assess how effectively burrow counts indexed ground squirrel abundance, we trapped squirrels and counted burrows in the same areas. Ground squirrels estivated early that summer, we assumed in response to drought conditions, so few grids were trapped. We did not evaluate pellet counts as a hare index because Dr. L. Scott Mills, University of Montana, and Dr. Kevin McKelvey, Rocky Mountain Research Station were already researching this issue.

Last winter (Dec. 2000 – March 2001), we doubled the number of winter technicians to increase our sampling effort. We also intensified our efforts to trap females and kittens; capturing kittens has become increasingly important to study dispersal. Last summer (May – August 2001), we continued relocating lynx throughout the day, and we quantified vegetation structure and composition at as many relocation points as possible. However, we will need to sample habitat characteristics at relocation points next summer until all points have been sampled. We also measured vegetation structure and composition at all den sites (N=13). Habitat measurements were taken at multiple spatial scales from the actual den structure to the adjacent forest stand. Additionally, we also completed our efforts to index ground squirrels, and we will report the results in the next annual report. Finally, we completed our study of lynx activity patterns.

LYNX TRAPPING AND HANDLING

We have radio collared 45 lynx (29 males, 16 females) since initiating the study in January 1998 (Table 1), and are currently monitoring 27 animals (11 females, 16 males). Last winter (December 2000 - April 2001), we captured four adult females, seven kittens, and one adult male; nine lynx were captured from Seeley and three from Lincoln (Table 2). We worked particularly hard to capture family groups, and we successfully trapped all members in three of the four family groups found on the study area.

Our ability to successfully capture family groups was due to our shift to box traps as our primary trapping technique. During the last two years, we explored different trap

options in an effort to efficiently capture lynx without frost damaging feet and toes. Frost damage can happen very quickly when nighttime temperatures suddenly drop, even when traps are checked every 12 hours. Pierre Canac-Marquis, a researcher from Québec, recently compared the physical damage associated with captures of 80 lynx from soft-catch traps, laminated-jaw traps, offset-jaw traps, and Belisle snares. He found that all traps were equally efficient (capture lynx / lynx causing trap closure) in terms of capturing lynx, but the Belisle snare was less likely to cut the animal's foot and much less likely to cause frost damage. We have captured lynx using Belisle snares, but this trap required constant attention to be effective. Last winter we began using a homemade box trap that effectively captured lynx, while being easy to maintain, and did not cause frost injury. We could also release non-target lynx without sedation. Thus, we could trap females and kittens within male home ranges with little worry of injuring resident males.

Of 102 lynx captures (initial captures plus recaptures), only one animal received an injury that required veterinary care. M44 was fine when the trap was initially checked, but he broke his leg as technicians approached the trap a second time with the capture gun. This male was caught in a #3 soft-catch trap. Apparently, the trap caught on a frozen stick and the animal's forward momentum broke his leg. This type of injury is difficult to prevent with foothold traps. The break was a compound fracture that required veterinary care. We transported the male to Dr. Conrad Orr, DVM, Missoula Veterinary Clinic, where he reset, pinned and cast the male's leg. We housed M44 at Seeley Lake in an outdoor pen that was isolated from human activity. M44 appeared to be healthy and gained weight during his nine weeks in captivity. We released the male where it was initially captured, and he remained on his home range throughout the summer and fall.

During October 2001, we used hounds to replace radio collars on four lynx in Montana and one in Wyoming. We were especially interested in recapturing subadults that were collared as kittens to ensure that their collars still fit. We pad the kitten collars with foam wrapped and duct tape. This provides room for growth, but firmly holds the collar on the kitten's neck in a manner that prevents the animal from catching its jaw under the collar. The collars on the subadults fit properly, so we will continue collaring

kittens using the same procedure. All captures with hounds were accomplished without incident, and all the animals appeared in good condition.

MORPHOMETRICS

The average weight of female lynx captured on the Seeley Lake study areas (Seeley Lake, Shafer, and Lincoln) was to 8.2 kg (SD = 1.4, Range = 5.1 (kitten) – 9.6, N = 8). Males weighed an average of 10.4 kg (SD = 1.5, Range = 6.5 (kitten) – 13.1 kg, N = 17, Table 3). The body length of females was slightly shorter (Average = 87 cm, SD = 4.9, Range = 79 – 95 cm, N = 10) compared to males (Average = 89.2 cm, SD = 7.7, Range = 78 - 102 cm, N = 18), but there was considerable overlap.

DENNING AND REPRODUCTION

Den Summary. - Before this study, the state of knowledge concerning lynx denning was based on four dens from two females in Washington (Koehler 1990). Given this limited knowledge, we continue to expend considerable effort studying den-habitat selection at Seeley Lake. To date, we have located 14 dens (11 natal, 3 maternal) of seven females (Table 4). Females typically localized their movements at den sites from 15-18 May (Table 4).

During the 1998 denning season, we failed to locate any dens from four collared females (Table 5). Two of the females never localized at dens, one died of starvation prior to denning, and the collar on the fourth female (F18) failed during early spring, but resumed transmitting signals during late summer.

During 1999, three of four females localized their movements at den sites (Table 5). Two of the three females produced litters of two kittens each; we counted kittens at four weeks of age so we did not detect early kitten mortality. The third female localized at a den, but she may have failed to give birth or her kittens died before we checked the site. The female (F18) that never localized her movements in 1999 did successfully produced kittens in 1998. F18 was observed with a male several times during the breeding season so we assume that she copulated but did not den.

In 2000, we monitored the denning behavior of five adult females (F01, F10, F14, F40, and F64), four of which localized their movements at a den site (Table 5). The four denning females produced a minimum of six kittens or 1.5 kittens per female. All four

females successfully raised at least one kitten to independence. F64, the female trapped during 1999/00 in Shafer Meadows, produced at least one kitten in 1999, but failed to den in 2000.

In the past, we had initially checked dens when kittens were one-month old under the assumption that older kittens could better cope with females moving them to a new den after handling. However, delaying our initial den check resulted in lost data. For example, we could not locate the month-old kittens of F10 when she denned in a large (10 m wide, 40 m and 1 m high) stack of woody debris; older kittens may hide when technicians approached the site. This spring we changed our protocol and entered dens when kittens were two weeks of age. Checking dens when kittens are two weeks of age will improve litter-size estimates.

During 2001, we monitored the den behavior of seven adult females, six of which localized to a den site (Table 5). Three (F10, F52, F70) of the six females produced kittens that survived to at least two weeks of age. These females produced a total of eight kittens; two females (F10, F70) produced litters of three kittens, and one female (F52) produced a litter of two (Table 4).

Den-site Fidelity. - Fidelity to den sites in subsequent years varied among the three females that denned in both 1999 and 2000. In 2000, F01 denned within 70 m of her 1999 den site, while F10 and F14 denned within 1018 m and 7327 m, respectively. F10 was the only female that denned in 2000 and 2001. Her 2001 den was located 2.9 km from her previous year's den.

Productivity. - Although our sample size is small, preliminary data suggest that lynx at Seeley Lake have low productivity. About 74% (14 of 19 potential den attempts) of adult females actually localized at dens, even through most females were observed with males during the breeding season. Litter size at Seeley Lake averaged about 2 kittens based on 1999 -2001 data (Table 4). Thus, preliminary data from Seeley suggested that lynx have low fecundity that is similar to Canadian populations when hares are at population lows (Poole 1994, Slough and Mowat 1996). Preliminary data also suggested that kitten survivorship was low. For example, we monitored survivorship of 10 kittens: four kittens in 1999 and six kittens in 2000. Only 50% (5 of 10 kittens) of

kittens survived to independence (Table 5). Last winter (Dec. 2000 – April 2001), we collared seven kittens (Table 6). One of the seven kittens died from fur trapping (see Mortality Factors), one kitten was lost (F73), and the remaining five are still alive. Monitoring kitten survivorship will be a high priority for the duration of the study.

MORTALITY FACTORS

We have documented 18 (11 males, 7females) lynx mortalities to date. The mortality rate of known-fate individuals (excluding "lost" and non-collared lynx - F58) was 47 % (N = 18 of 38 lynx); 61 % of mortalities were males and 39 % were females (Table 7). The causes of mortality described in this report are tentative because five (M44, M63, M02, F14, F01) mortalities have not received necropsies; all necropsies should be complete by February 2002. The mortality factors for M44, F14, and M63 were included in this report because the cause of death appeared clear; however, M02 and F01 were excluded until necropsies are complete.

Starvation was the most common mortality agent, accounting for 38 % of mortalities (3 males, 3 females, Table 7). Two males died of starvation during mid to late winter and the four remaining lynx (1M, 3F) starved during early spring (March – April). These preliminary data suggested that late winter through early spring were particularly stressful for lynx in terms of food availability. We assume that most starvations occur from late winter through early spring because at this time of year snowshoe hare (*Lepus americanus*) populations are at yearly lows and alternative prey such as Columbian ground squirrels (*Spermophilus columbianus*) are unavailable. In addition, lynx breed during early spring, presumably adding to their energetic demands. Presumably, foraging improves during late spring-early summer as snowshoe hare leverets become available and ground squirrels emerge from hibernation.

Predation from mountain lions (*Puma concolor)* was the second most common mortality factor accounting for 31% of lynx mortalities (N = 5). All lion-caused mortalities occurred during the snow-free period (May-Nov.) when both species had overlapping spatial-use areas. During winter, few lion tracks were observed in lynx home ranges as lions move to lower elevations to hunt ungulates.

Finally, trapping and illegal shooting accounted for 25% (N = 1 male shot; 2 males and 1 female trapped) of mortalities. In January 2001, M42 was killed in a 330 conibear trap intended for wolverine (*Gulo gulo*) after we had monitored M42's movements for 11 months. The trap was placed in a leaning tree that held a large meat bait in a legal set (Jeffrey Campbell, Fish and Game Warden, MFWP. pers. comm.). Also, in January 2001, a subadult female (F38) died from trap-related injuries. We recovered the female's carcass in a natural position without any signs of scavenging. She had a small pool of blood under her body, and her hind leg had a large patch of exposed skin where the fur was rubbed. Technicians followed old snowshoe tracks found within ten meters of the carcass to a sprung trap with lynx hair in the closed trap jaw. The carcass of F38 was in good body condition, but she had an empty stomach except for lynx hair. Her leg was not broken from the trap, but there was extensive muscle damage. Lesions in her heart and skeletal muscle suggested the cause of death was capture myopathy; it appears the animal was in the trap for a long time before being released. The incident was reported immediately to Bill Koppen, Fish and Game Warden, MFWP. The third trapping incident involved M50, a kitten of F01 that we collared last winter. In early March, we recovered the carcass of M50 with a #2 long-spring trap on its foot. The 14-gauge wire that originally anchored the trap was broken and the kitten apparently starved with the trap on its foot. The anchor wire was shiny and new suggesting the kitten was not captured in an old "forgotten" trap, but was caught in a trap that had been recently set. The incident was immediately reported to Bill Koppen, Fish and Game Warden, MDFWP.

Last winter, we learned from conversations with local residents that lion hunters at Seeley Lake treed lynx on at least 3 occasions (2 on Richmond Ridge, 1 near Lindbergh Lake). We assume these lynx were released, but these instances suggest that treeing of lynx during lion season is common on our study area. On 9 January 2000, lion hunters illegally shot M30, only four days following our original capture of this animal on Richmond Ridge. The incident was immediately reported to Bill Koppen, MDFWP, and the case was tried in court.

In December 2000, we believe lion hunters may have killed a second male (M36), but this is based on conjecture. We collared M36 last spring as a kitten, and monitored

his movements until he established a home range on Marshall Creek as a subadult. We were concerned for this animal's safety because many houndsmen hunt mountain lions in Marshall Creek. We were able to locate M36 on 12/07/00 just seven days after the opening day of lion season. However, from the next day on we were unable to locate the male. We conducted an aerial search of the Mission and Swan ranges, including the southern Bob Marshall Wilderness, but still could not locate the male. Although a sudden long-distance dispersal or radio failure cannot be ruled out, it seems most likely that M36 may have been killed illegally by lion hunters.

MOVEMENTS AND HOME RANGE

Home Range. - Although interpreting the size of spatial-use areas is difficult (White and Garrott 1990), differences in home-range size of northern versus southern lynx populations may revel important ecological issues. For example, lynx at Seeley Lake have large spatial-use areas compared to northern populations (Aubry et al. 2000). The size of annual home ranges (95% fixed-kernel estimates) averaged 216 km^2 (SE = 84 km^2, N = 7) for males and 88 km^2 (SE = 25 km^2, n=4) for females (Table 8). Lynx at Seeley Lake require home ranges that are about twice as large as those used by northern populations during high periods of the hare cycle, and approximately the same size as home ranges during cyclic lows. Hare densities at Seeley Lake have remained low during the last four years, averaging about 0.5 – 2.0 hares per hectare (S. Mills, personal communication 2001). This low hare density is similar to northern populations during cyclic lows (Hodges 2000). We assume that lynx at Seeley Lake require large spatial-use areas because of low prey densities. Thus, small reductions in prey densities at Seeley Lake could significantly alter their spatial-use patterns and may ultimately impact population persistence.

Exploratory Movements and Dispersal. - Lynx from southern populations occasionally make "exploratory" movements outside their usual spatial-use areas before returning to their home ranges (Squires and Laurian 2000, Aubry et al. 2000). Exploratory movements may provide a mechanism for southern populations to locate food resources or may help locate potential mates within a naturally patchy landscape. To date, four males made exploratory movements outside their established home ranges,

mostly during mid-summer. M4 (4-6 yr old estimated based on tooth wear and staining) left his home range on 21 July 1998 and traveled 28 km southwest. After about seven days, he returned to his home range on 28 July. M6 (2-4 yr old) left his home range on 29 July and traveled south for 24 km, and he remained in the new area throughout the summer. M20 (1-2 yr old) moved extensively throughout the spring and summer. On 18 March, M20 traveled west 22 km, but was back near the center of his activity area by 2 April. On 21 July, M20 was located in the Bob Marshall Wilderness, and by 28 July he traveled a straight-line distance of 39 km to a site near Ovando, MT. This male had to cross a two-lane highway and the Blackfoot River (about 30-40 m wide) during this exploratory movement. M20 remained near Ovando for two days before he moved and could no longer be located from aircraft. On 12 August, we relocated M20 approximately 50 km north of Ovando, and the male moved 17 km back to the center of its territory by 20 August. M28 (3-5 yr-old) left his home range on approximately 6 July, and he was not relocated despite extensive aerial searches. This animal returned to his home range on 3 August where he remained throughout the summer. In addition to these animals, four other lynx (M03, M36, F51, F73) made extensive pre-dispersal movements before they presumably dispersed and could no longer be relocated.

We have "lost" five males and three females since the study began, despite extensive aerial searches for these individuals (Table 1). We do not know whether these animals dispersed or if their radios failed. We have conducted extensive aerial searches in the Mission Mountains, Glacier National Park, and the Bob Marshall Wilderness Area for "lost" lynx. In Northwest Territories, dispersal distances ranged from 17 to 930 km and dispersal rates were similar between sexes (N = 60 radio collared and 31 eartagged lynx, Pole 1997). Howard (1960) recognized two types of dispersal. Environmental dispersal was when animals moved in response to unfavorable conditions, such as declining hare densities, and "innate dispersal" described when animals moved for genetic reasons. Limited data indicate that hare populations have declined at Seeley Lake during the last four years (P. Griffin, pers. comm. 2001). We do not know if lynx at Seeley Lake disperse in response to lower prey abundance or if they disperse for genetic reasons. However, the fact that we have "lost" lynx illustrates the need for increased

aerial monitoring which is difficult during the winter and often impossible during fire season, or for a shift to satellite telemetry.

WINTER FOOD HABITS

From December, 1998 – March, 2001, we located 58 winter kills. During winter, five species of prey were consumed by lynx including snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), blue grouse (*Dendragapus obscurus*) northern flying squirrel (*Glaucomys sabrinus*), and white-tailed deer (*Odocoileus virginianus*). In terms of prey biomass, the winter diet of lynx consists of 96% snowshoe hare, 3% red squirrel, 1% blue grouse, and < 1% northern flying squirrel (Table 9). In addition, we documented two instances of a large male lynx (M5) killing white-tailed deer (*Odocoileus virginianus*) that were apparently caught in deep snow. The male returned to the deer kills until the carcasses were consumed. During winter, lynx also fed on carrion including white-tail deer, elk (*Cervus elaphus*), and mountain lion.

ACTIVITY PATTERNS

Lynx were fitted with radio collars (Advanced Telemetry Systems, 185 g) that included a mercury switch that increased the pulse rate when they were active. A microprocessor in the collar counted the number of mercury switch activations per hour, and then transmitted the activity data for the entire 24-hr period twice a day. We used these counts as an index of the animal's activity patterns. Determining activity patterns of lynx is an important first step toward assessing potential direct impacts of winter recreation, and provides empirical data that can be used to program satellite collars.

Activity data may also provide insights regarding summer food habits. Summer food habits are very difficult to study because scats are rarely located, even with scat dogs. We have observed lynx during the summer foraging on Columbian ground squirrels, but we do not know to what extent lynx alter their behavior to use this resource. Although we cannot quantify ground squirrel use directly, a shift to a diurnal activity pattern along with habitat use data may suggest how common it is for lynx to shift to ground squirrels as an alternative prey.

Technicians used conventional telemetry to approach collared lynx just prior to the collar's download transmission until he/she received a strong signal. Activity data were then recorded using an ATS ™ DC II data logger. Technicians monitored animals sequentially to distribute the sample throughout the season. However, during early spring, technicians increased their sampling of females to determine if denning females had consistent activity patterns so that we could enter dens while females are foraging. Activity values were averaged by lynx and season to describe daily activity patterns.

During 2001, lynx activity was recorded for a total of 187 days. Of the total, activity was recorded during 68 d on 11 lynx (6 females, 5 males) during the winter (20 January – 21 March, 2001) and 119 d on 11 lynx (8 females, 3 males) during the summer (7 May – 5 August, 2001). Lynx patterns were consistent regardless of sex or season (Fig. 1). Lynx were active between 3:00 – 6:00 before declining between 7:00 - 9:00. Lynx then increased their activity between 10:00 - 12:00, and then again between 14:00 – 16:00. Activity then generally declined from early evening (17:00) through midnight (24:00).

Although seasonal activity patterns were consistent (Fig. 1), there was considerable variation among individuals (Figs. 2-5). Females were more active than males throughout the year (Fig. 1) with much variation among individuals, especially during the summer. For example during the summer, F01 and F70 were at low activity levels between 7:00 – 9:00 while F10 and F14 were at high activity levels (Fig. 2). Daily activity patterns of males were also variable among individuals, but less than females, especially during the summer (Figs.4-5).

Activity data suggested that lynx are active periodically throughout the 24-hr cycle, especially during the early morning hours between 1:00 and 6:00 and late afternoon. Although hares are mostly nocturnal to crepuscular, they are also active during the day (Boulanger and Krebs 1996, Hodges 1998). Thus, the activity patterns of hares may explain why lynx were active during late night and early morning. It is interesting that daily activity patterns of lynx were similar during winter or summer. Seasonal changes in photoperiod apparently had little affect on daily activity patterns. If lynx had shifted to Columbian Ground Squirrels as a major prey species during the

summer, we would expect their activity patterns to increase during daylight hours. Given that no shift was documented, lynx apparently did not shift activity patterns in response to ground squirrel availability.

We hypothesize that winter recreation, such as snowmobiling, would have less direct effects if lynx were primarily nocturnal, and used secure daybeds during the day. However, we found that lynx were active and presumably hunted during the day when snowmobiles were in use. These data only indicate that overlap exists between snowmobile recreation and lynx activity patterns, but these data are not sufficient to determine if snowmobile recreation truly impacts lynx populations.

HABITAT SELECTION

Denning. - From June – August 2001, we sampled habitat characteristics at all den sites used to date. However, we were not able to sample random "den sites" to determine which habitat attributes were used in greater proportion to availability. Most dens (9 of 13 maternal and natal dens combined from 7 females) were located in mature spruce/fir forests, three were in regenerating clearcuts, and one was a 30 yr regenerating partial-cut with a mature overstory (Table 4). All 14 dens had abundant woody debris, usually in the form of large-diameter logs. However, smaller (< 30 cm) diameter logs were also used, especially when "jackstrawed." Wind-thrown trees appeared to be desired habitat for den sites.

We waited until females with kittens vacated den sites before conducting habitat sampling. We quantified habitat characteristics at three spatial scales using the same vegetation measurements as at summer relocation points. First, we established a 22.4 m transect centered on the actual den at a random azimuth. A 4-rope system was used to define 11.2 m (0.01 ha) and 5.6 m (0.04 ha) fixed-radius plots. We used the outer (11.2 m) fixed plot to sample trees and snags > 8 cm by species and dbh, and the 5.6 m radius plot to sample saplings (< 8 cm dbh and greater 0.5 m in height) by species. Shrub cover (woody, non-tree vegetation < 2 m tall) was estimated by genus using line-intercept sampling (Krebs 1989) along the 22.4 m tape. We estimated the tree basal area of trees at dens using a variable plot (20 BAF prism). Slope (%) and aspect (degrees) were measured using a clinometer and compass. We quantified canopy cover using a

moosehorn densitometer read vertically at 25 points located systematically in a 11.2 by 11.2 m grid centered on the den; we also inverted the densitometer to estimate small-diameter woody litter and nonvascular plants. Horizontal cover was measured using a cover board read in the four cardinal directions, and log volume and diameter class were recorded for all large-diameter woody debris that crossed the 22.4 m tape. Finally, we also measured the physical size of the den depression/cavity, and we photographed each den as part of the record.

We also sampled habitat characteristics of dens at the forest-stand level. Eight vegetation plots were established at 50 m and 100 m as illustrated in Figure 1. Plots were measured as described above. We also quantified relative prey abundance using pellet and hole-count transects, and we measured the distance to permanent water sources. These data were entered into the computer this fall, and we will begin preliminary analyses this spring.

Winter Habitat Use. - Last winter (December 2000 – March 2001), we studied habitat-use relationships by back tracking lynx and comparing "used" tracks to those randomly available in the animal's home range. Two technicians forward or backtracked the lynx depending on snow conditions and plotted the animal's exact (± 3m) trail using a differentially-correctable GPS. We backtracked lynx for 3 kms. This distance was sufficient to cross several habitat types while still being achievable during a 10-hr workday. However, during spring, tracking conditions often deteriorate because of snow crusting, thus it becomes increasingly difficult to follow a 3 km track. On both "use" and "random" tracks, we measured forest structure and composition at 200 m intervals along a 1 km sample segment of the track (5 plots/track) with a random start within the first kilometer of the track. At each sample point, we estimate tree basal area, tree density (5.6 m plot) by size class, canopy closure (visually estimated), slope, aspect, horizontal cover, snow depth, and snow penetrability. Habitat plots were also measured at daybeds and kill sites using the same procedures. We index prey (hares, red squirrels, and grouse) abundance by counting snow tracks and recording at 100m intervals. Thus, we can compare relative prey abundance by habitat type. We also plot track crossings of

potential competitors such as bobcat, coyote, and cougar on the GPS, as well as snowmobile crossings.

We plan to use resource selection functions to study winter habitat selection (Manly et al. 1993). This individual-based method requires a high sampling intensity per animal. In previous annual reports, we evaluated sample size issues in terms of plots per transect, transects per individual, and the number of individuals that are needed to adequately evaluate habitat selection. We concluded from our analysis that we needed 12 to 40 plots per transect to decrease our overall coefficient of variation to 0.25. However, we found that measuring more than 5 plots per transect along with other data logging was impossible to complete in a 10-hr workday. We continue to sample vegetation plots along transects because they provide a direct measure of habitat features that cannot be gleaned from GIS analyses. We also compliment these plot data by recording general habitat information such as forest species and structural classes along the entire length of the track. In winter 1999 - 2000, we attempted to increase the number of plots by recording fewer variables and by modifying field procedures. We believed these "quick" plots failed to adequately describe habitat features. Thus, we reverted to the original five plots per transect, and accepted the fact that we must contend with high variability. Plot data are also valuable for determining how habitat features along tracks compare to those at daybeds and kill sites.

Preliminary data suggest that to achieve a statistical power of > 0.7 at an alpha level of 0.10, we will need to increase our sample size to approximately 20 animals with a sampling intensity of at least 10 – 15 transects per lynx (*See Annual Report 1999-2000*). To help achieve this goal, we doubled the size of our winter sampling crew to eight technicians; four technicians were employees and the remainder was volunteers. We currently have sampled winter backtracks for 13 lynx at Seeley Lake (Table 10). We achieved a sampling intensity of about 12 pairs of "use" and "random" transects for 10 of the 13 lynx (Table 10). The remaining animals were relocated only a few (<10 points) times because they were recently captured or monitoring had ended (lost and dead).

We plan to sample approximately 50-55 pairs of "use" and "random" back-track transects this winter (December 2001 - March 2002). This assumes a sample of four

pairs of transects per week for 13 weeks (2 wks Dec., 4 wks Jan., 4 wks Feb., 3 wks March). This sample effort could be expended by increasing the sampling intensity per animal or by sampling additional animals. White and Garrott (1990) believe that greater understandings of resource selection are achieved by increasing the number of animals sampled, at the expense of sampling intensity. Thus, we will continue sampling lynx, including three "new" animals, until all individuals are sampled at an intensity of 15 backtracks per animal.

Summer Habitat Use. - We will model habitat selection by building resource selection functions using logistic regression. Last summer (May – August 2001), two two-person tracking crews located lynx approximately 200 times during the field season. At the beginning of the summer, eight lynx (F01, F10, F14, M04, M05 - mortality, M06 - lost, M07, M26) had a fairly high sampling intensity of about 30 relocation points per animal and five lynx (F18 - mortality, F40, M02 - mortality, M28-lost, M32) had 15-20 summer relocations. The remaining 10 lynx (F51, F52, F55, M54 wilderness, F64, F70, M34, M53, M61, M62) had few summer relocation points (<10). Individuals receiving a low sampling intensity were mostly newly captured animals or those living in remote areas such as the Bob Marshall-Great Bear Wilderness Area.

Our goal last summer was to relocate as many lynx as possible between 25 to 30 times during the summer. By the end of the summer, 17 lynx had greater than 20 summer relocation points (Seeley and Lincoln), three had between 10-20 relocations, and four had a low sample intensity (<10 locations). To date, we sampled habitat features at 400 pairs of "used" and "random" points (Table 10). Given that obtaining high-quality relocations was our highest priority, we were unable to quantify habitat characteristics at 200 pairs of relocation points. This sampling will need to be accomplished during June - August 2002.

FUTURE RESEARCH

During our first four years at Seeley Lake, we primarily studied stand-level habitat relationships. These understandings are critically important to conservation planning, and are currently unknown for northern or southern populations. These understandings are needed before private, state, and federal land managers can assess

how land-use practices, such as pre-commercial thinning, may impact habitat use. During the winter, we have already backtracked lynx over 200 kilometers, and we will continue this work for the next three months. By the end of this winter, we hope to have sufficient data to finalize our report concerning winter habitat selection. We also hope to complete our summer habitat-use studies once our remaining vegetation plots are quantified. Preliminary analyses for both studies may indicate that additional work is necessary, but we hope this will not be the case.

As our initial objectives are accomplished, we will shift our efforts toward achieving longer-term objectives that address major information gaps. Thus, future research will focus on the following issues.

1) *Habitat-use within Managed and Non-managed Landscapes.* - Our current habitat-use studies have primarily been conducted in managed landscapes. Thus, the understandings generated from these data are best applied to managed forests. We have collared lynx in the Bob Marshall Wilderness Complex to achieve a more representative sample, but additional animals are needed to obtain a representative sample that could include animals from Glacier National Park, Bob Marshall Wilderness Complex, and the Garnet Range. Based on past experience, studying lynx movements and habitat-use patterns in non-managed areas will require using satellite collars equipped with GPS/ARGOS transmitters, especially given the limited use of aircraft during the winter. ARGOS collars for lynx are currently available, and collars that transmit precise GPS locations via the ARGOS system are under development. We are currently working with two venders to develop GPS collars for lynx, and accuracy tests will begin as soon as test units are available. We will continue our efforts to secure necessary funding to study lynx habitat use in non-managed areas.

2) *Habitat Selection of Den Sites.* - We will continue studies of den-site selection given our current limited sample. We will collar as many females as possible in managed and non-managed landscapes, and we will continue evaluating habitat selection at three spatial scales (den structure, forest stand,

and landscape). Quantifying habitat relationships at the most resolute scales requires ground sampling, while landscape-level relationships will be evaluated through a GIS analysis of satellite imagery or low-elevation aerial photography.

3) *Movements, Corridors, and Habitat Connectivity.* - McKelvey et al. (2000) found that harvest records for lynx in Montana were synchronized with Canadian populations, but with a 3-yr lag. We do not know if peaks in the Montana population are from lynx physically moving to the state from Canada, or if lynx populations across the entire region respond to similar environmental factors. Peaks in the Montana population usually occur during the first three years of each decade. Thus, we have an excellent opportunity to assess how lynx traverse landscapes in terms of habitat connectivity, including use of corridors. Objective six speaks to the importance of assessing how lynx respond to natural and anthropogenic barriers, such as travel corridors and human development. We have had limited opportunities to study large-scale movements of lynx at Seeley Lake, but a larger sample of animals that is spatially well distributed across northwestern Montana will be needed to rigorously evaluate habitat connectivity.

4) *Demography. Is Seeley a source or a sink population?* - We are studying lynx demography to the extent possible given the duration of our study and our limited sample. We have made significant progress toward identifying primary mortality factors, and we have collected valuable data regarding fecundity and kitten survivorship. However, additional demographic data are needed to understand the population status of lynx at Seeley Lake, and to understand how additive mortality such as trapping and illegal shooting potentially impact populations. We will continue trapping females and kittens whenever possible on the Seeley study area. We will model the population trajectory of lynx at Seeley Lake as demographic data becomes available. However, we also think it is important to study lynx demography in non-managed landscapes to provide a context when evaluating Seeley Lake data.

5) *Dispersal and Metapopulation Structure.* Understanding how lynx at Seeley Lake persist as part of a larger metepopulation is an important information need for conservation planning. Our current effort to document dispersal among populations is inadequate; we have lost (or radios have failed) eight individuals during the course of the study. Given that dispersal-events are rare, any movements outside the study area that are not documented greatly impact our ability to understand dispersal movements. In addition, monitoring the extensive movements of kittens and subadults at Seeley Lake is difficult with aerial telemetry given weather constraints and closures of airspace related to fire fighting. Thus, we will seek funding to collar all lynx, especially kittens, with units that contain both satellite and conventional telemetry. This will prevent lost collars and allows us to document dispersal regardless of movement distances. Incorporating satellite collars is expensive and will need to be phased in over the next few years.

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Table 1. Sample period and status of all lynx captured at Seeley Lake, MT, from January 1998 (project initiation) – April 2001.

Lynx	Date Initial Location	Date Last Location	Status
		FEMALES	
F01	19 January 99	22 November 01	Mortality
F08	05 February 98	18 March 98	Mortality
F09	09 March 99	09 March 99	Mortality
F10	27 January 98	Current [1]	Present
F14	27 January 98	6 October 01	Mortality
F18	23 September 98	17 November 00	Mortality
F38	09 March 00	25 January 01	Mortality
F40	22 March 00	Current	Present
F51	7 January 01	10 June 01	Lost
F52	9 January 01	Current	New Capture [2]
F55	23 January 01	21 June 01	Lost
F57	13 February 01	Current	New Capture
F58 [3]	16 February 01	(non-collared)	Mortality
F64	12 April 00	Current	Present
F65	12 April 00	12 April 00	Mortality
F70	20 March 01	Current	New Capture
F73	02 April 01	16 September 01	Lost
		MALES	
M02	27 January 98	23 May 01	Mortality
M03	08 February 99	17 March 99	Lost
M04	27 January 98	Current	Present
M05	02 March 99	07 August 00	Mortality
M06	27 January 98	3 January 01	Lost
M07	02 March 99	Current	Present
M12	02 March 98	01 May 98	Mortality
M16	17 February 98	18 March 98	Mortality
M20	02 March 98	06 October 98	Mortality
M22	02 March 98	01 May 98	Mortality
M26	27 January 98	Current	Present

Table 1. cont.

Lynx	Date Initial Location	Date Last Location	Status
M28	02 April 98	01 October 98	Lost
M30	07 January 00	07 January 00	Mortality
M32	18 January 00	Current	Present
M34	22 March 00	Current	Present
M36	09 March 00	7 December 01	Lost
M42	22 March 00	11 January 01	Mortality
M44	07 June 00	25 January 01	Mortality
M46	31 March 00	13 July 00	Lost
M50	18 December 00	5 March 01	Mortality
M53	25 January 01	Current	New Capture
M54	18 January 01	Current	New Capture
M56	8 February 01	Current	New Capture
M59	23 February 01	Current	New Capture
M61	12 April 00	Current	Present
M62	12 April 00	Current	Present
M63	12 April 00	26 February 01	Mortality
M71	20 March 01	Current	New Capture
M72	21 March 01	Current	New Capture

[1] = Lynx currently being monitored through ground-based and aerial telemetry.
[2] = "New Capture" includes lynx captured between December 2000 – April 2001.
[3] = Non-collared female walked into snowmobile parking area ignoring people. It appeared in starved condition and died that night.

Table 2. Captures of non-collared lynx at Seeley Lake and Lincoln, Mt, - December 2000 – April 2001.

Lynx ID	Capture Date	Drainage	Relationship	Estimated Age (yrs)
F51	01/07/2001	Benedict Cr.	unknown	1.5
F52	01/09/2001	Snowbank Lake	unknown	5+
F55	01/23/2001	Boles Cr.	Mother, F55 family	2-3
F57	02/13/2001	Boles Cr.	Kitten of F14	9 months
F70	03/20/2001	Richmond Cr.	Mother, F70 family	2-3
F73	4/02/2001	Sauerkraut Cr.	unknown	10 months
M50 [1]	12/09/2000	Cottenwood Cr	Kitten of F01	9 months
M53	01/11/2001	Snowbank Lake	unknown	2-3
M56	02/08/2001	Boles Cr.	Kitten of F14	9 months
M59	2/23/2001	Boles Cr	Kitten of F55	9 months
M71	03/20/2001	Richmond Cr.	Kitten of F70	9 months
M72	03/21/2001	Richmond Cr.	Kitten of F70	9 months

[1] = winter mortality

Table 3. Morphometric data of lynx captured at Seeley Lake, Montana – January, 1998 – March, 1999

Lynx ID	Age Class	Body Length (cm)	Shoulder Height (cm)	Weight (kg)	Right-ear Tuft (mm)	Left-ear Tuft (mm)
			FEMALES			
F01	young adult 2-3	85.9	50.6	8.7	44	44
F08	old adult 4-6	86.3	43.8	9.6	59	65
F09	old adult 3-5	89.7	50.6	7.5	58	52
F10	young adult 2-4	86.3	54.4	8.9	49	48
F14	young adult 2-4	86.3	42.5	7.8	48	47
F18	old adult 3-5	87.5	52.5	9.2	57	56
F38	kitten	78.7	40.6	5.1		
F40	Adult >4	95.3	54.9			
F64	Adult 3-5	87.6	53.3	8.5	51	51
F65	young adult 2-3	78.7	45.7		44	44
Avg. (SD)		**86.6 (4.9)**	**49.1 (5.3)**	**8.2 (1.4)**	**51 (6.1)**	**51 (7.0)**
			MALES			
M02	young adult 2-3	91.3	50.0	8.1	36	39
M03	Kitten <1k	78.2	50	6.5	37	36
M04	old adult 4-6	90.0	51.3	11.1	49	49
M05	young adult 3y	97.4	52.6	12	48	51
M06	young adult 2-4	85.0	45.0	12.0	46	44
M07	old adult 4	98	56.4	12.25	48.5	46

Table 3. cont.

Lynx ID	Age Class	Body Length (cm)	Shoulder Height (cm)	Weight (kg)	Right-ear Tuft (mm)	Left-ear Tuft (mm)
M12	young adult 2-4	95.3	48.3	11.1	54	58
M16	old adult 4-6	85.0	51.3	10.5	46	50
M20	young adult 1-2	92.5	50.0	7.6	45	47
M22	young adult 2-4	86.3	56.3	9.1	41	41
M26	young adult 2-4	82.5	51.3	10.2	43	42
M28	old adult 3-5	91.3	56.9	13.1	59	59
M30	young adult 2.3	101.6	53.3	10.1	42	49
M32	young adult 2-3		49.5	9.1		
M34	adult 3-4			10.5	48	51
M36	kitten	81.3	48.3			
M42	young adult 2			9.0		
M44	adult 3-5			11.0	44	44
M46	adult 3-5	100.3	54.6		44.0	0
M61	adult 3-4	88.3	54.0		48	51
M62	adult 3-5	88.9	56.5		64	67
M63	young adult 1.5	77.5	53.3			
AVG. (SD)		**89.2 (7.7)**	**52.0 (3.5)**	**10.2 (1.8)**	**46.7 (6.7)**	**45.7 (13.3)**

Table 4. Chronology, litter size and habitat description of radio-collared lynx denning near Seeley Lake, MT.

Lynx Number	Date Female Initially Localized (Natal) or Moved (Maternal)	Natal (N) / Maternal (M) Den	Litter Size	General Habitat of Immediate Den Area
F01	05/21/1999	N	0 [1]	Mature spruce/fir forests with abundant woody debris.
F01	05/18/2000	N	1 [2]	Mature spruce/fir forests with abundant woody debris.
F10	05/15/1999	N	2	Mature spruce/fir forest with abundant woody debris near edge of clearcut.
F10	05/18/2000	N	0	Mature spruce/fir forests near stream bottom.
F10	05/07/2001	N	3	Partial cut containing 30 yr old regeneration under an overstory of mature trees.
F14	05/22/1999	N	Kittens moved [3]	Sparse regenerating clearcut with stacked woody debris.
F14	05/22/1999	M	2	Sparse regenerated clearcut with large woody debris.
F14	05/18/2000	N	2	Approximate 30 yr-old regenerating stand with very extensive woody debris.
F40	05/25/2000	N	Kittens moved [3]	Mature spruce/fir stand with woody debris.
F40	unknown	M	2	Mature spruce/fir stand with woody debris.
F52	05/22/2001	N	2	Mature forest blow down stacked about 1.5 m, extending 500 m by 100 m.

Table 4. cont.

Lynx Number	Date Female Initially Localized (Natal) or Moved (Maternal)	Natal (N) / Maternal (M) Den	Litter Size	General Habitat of Immediate Den Area
F52	unknown	M	2	Mature forest in between 20-yr regenerating clearcuts in blow down stacked about 1.5 m, extending 500 m by 100 m.
F55	05/16/2001	N	0	Mature forest with abundant woody debris.
F70	05/10/2001	N	3	Natal den located in mature 40 m leave strip between cuts; female immediately moved her den to a mature forest stand.

[1] = No kittens present at one-month den check.
[2] = A single kitten was verified in December, 2000. Kittens could not be located in early June, but her high mobility when approached suggests she was carrying a single kitten in her mouth when researchers entered her den area.
[3] = Kittens moved to maternal den before natal den check.

Table 5. Productivity of radio-collared lynx at Seeley Lake.

Year	Total Females Monitored	Adult Females Monitored during Denning	Females Localizing at Den Sites	Females Producing Kittens	Kittens Produced (2-4 wk olds)	Kittens Surviving to Independence
1998	4	3	1	unknown[1]	?[1]	2
1999	4	4	3	2	4	1
2000	5	5	4	4	6[2]	4
2001	9	7	6	3	8	?[3]

[1] Radio failed so den was not located.
[2] During 2000, 2 of 4 dens were not located. In these cases, kittens were not counted until first snow so early mortality from denning to first snow was not monitored.
[3] Surviving kittens will be unknown until February, 2001

Table 6. Status of lynx collared as kittens (approximately 9-10 months of age), Seeley Lake, MT as of December, 2001.

Lynx ID	Date	Relationship	Capture Location	Status	Mortality Agent
M03	2/4/99	Young of F18	Seeley Lake	Lost	N/A
M36	2/29/00	Young of F40	Seeley Lake	Lost[1]	Potentially poached[1]
F38	3/1/00	Unknown	Seeley Lake	Mortality 1/25/01	Trapping
M63	3/7/00	Young of F64	Schafer	Mortality 2/26/01	Starvation
M50	12/9/00	Young of F01	Seeley Lake	Mortality 3/5/01	Trapping
M56	2/8/01	Young of F14	Seeley Lake	Alive	N/A
F57	2/13/01	Young of F14	Seeley Lake	Alive	N/A
M59	2/23/01	Young of F55	Seeley Lake	Alive	N/A
M71	3/20/01	Young of F70	Seeley Lake	Alive	N/A
M72	3/21/01	Young of F70	Seeley Lake	Alive	N/A
F73	4/2/01	Unknown	Lincoln	Lost	N/A

[1] M36 was monitored throughout the year and established a home range, but could not be relocated a few days after lion season began; although the collar may have failed, it seems most likely the animal was poached (see Mortality Factors).

Table 7. Mortalities of radio-collared lynx, Seeley Lake, MT, January 1998 (project initiation) – December, 2001.

Lynx ID	Mortality Date	Estimated Age (yrs)	Mortality Factor	Comments
M12	5/5/98	2-4	Lion	Canine-tooth holes in skull exactly fit those of mountain lion. Skull partially crushed. Femur broken and partially eaten.
M16	3/23/98	4-6	Starvation	Carcass estimated to be 48 hr old; no sign of scavenging. Lynx was in sprawled position on snow. Emaciated.
F08	3/18/98	4-6	Starvation	Carcass approximately 4-7 days and partially scavenged (front legs, neck and head in tact). Emaciated.
M20	10-6-98	1-2	Lion	Fresh kill, blood still flowing, much hemorrhaging and large puncture at base of skull. Hair plucked from dorsal region and carcass dragged short distance from kill site.
M22	5/1/98	2-4	Unknown	Dropped collar found on forest floor approximately 100 m from gated road. We were unable to force the collar over the heads of our moralities so we assume the carcass was dismembered.
F09	3/16/99	3-5	Starvation	Remains included only leg and head plus collar in a large regenerating clearcut. Head buried in 2-3" new snow. No tracks or sign of fight. Femur lacked any marrow.
F18	11/15/99	4-5	Lion	Hemorrhaging, puncture wounds and crushed skull. Carcass under 2 feet snow.
M30	1/9/2000	1-2	Shot	Lynx treed by lion hunters and shot.

Table 7. cont.

Lynx ID	Mortality Date	Estimated Age (yrs)	Mortality Factor	Comments
F65	May, 2000	2-3	Starvation	Carcass recovered within a few days of death. Carcass only weighed 4 kg with hip and shoulder bones protruding. This cat was in poor condition when originally captured in March.
M05	8/15/00	3-4	Lion	Carcass was found a week to ten days after death, and was quite desiccated. Necropsy indicated puncture wounds to back of skull, indicating cause of death was predation. Spacing of bite wounds was consistent with mountain lion.
M42	1/11/01	3-4	Trapped	Killed in a 330 conibear trap. The trap was set on leaning tree below a large meat bait originally intended for wolverine.
F38	2/16/01	1 yr, 9 months	Trapped	Carcass found near trap set with injuries to rear leg that appeared to be trap related. Trapper stated that the cat was captured and released shortly before it was recovered dead.
M44	1/23/01	4-6	Starvation	Carcass not necropsied.[1] Bones on hips, ribs and shoulders are protruding. The non-scavenged carcass was found in a curled position and there was no sign of predation. The animal apparently died of starvation.
M63	2/26/01	1 yr, 9 months	Starvation	Carcass not necropsied. Animal found curled under tree. Carcass only weighed 5.7 kg and appeared quite emaciated.
M50	3/5/01	1 yr, 9 months	Trapped	Male broke a foot-hold trap free from its anchor. The trap that remained on its foot caused it to die of starvation.
M02	5/23/01	5-6	Predation (?)	Carcass not necropsied. Body highly contorted but not fed upon. Possible wounds to back of head.

Table 7. cont.

Lynx ID	Mortality Date	Estimated Age (yrs)	Mortality Factor	Comments
F14	10/06/01	5-6	Lion	Carcass not necropsied. Skull crushed and hemorrhaging apparent. Size and placement of head wounds consistent with lion predation
F01	11/22/01	5-6	Unknown	Carcass not necropsied. Only head and leg recovered. Animal had been scavenged and dead for some time.

[1] We plan to necropsy all carcasses by February, 2002

Table 8. Preliminary annual home ranges of lynx, Seeley Lake, Montana, 1998 - 2001.

Lynx	Number of relocations	Fixed Kernel Home Range (km^2)		
		95%	90%	50%
		Annual, Female		
F01	99	50	32	8
F10	134	95	79	23
F14	149	157	117	30
F18	64	50	40	9
Average (SE)		88 (25)	67 (20)	18 (5)
		Annual, Male		
M02	106	516	329	44
M04	118	175	143	49
M05	75	59	51	28
M06	119	552	411	78
M07	78	64	56	24
M26	93	44	38	13
M32	39	100	98	20
Average (SE)		216 (84)	161 (56)	37 (8)

Table 9. Preliminary winter food habits of Canada Lynx, December, 1998 – March, 2001, Seeley Lake, Montana (N = 58 kills).

Prey species	Number of kills (% biomass [1])			
	Winter 1998-99	Winter 1999-00	Winter 2000-01	Total
Blue Grouse (*Dendragapus obscurus*)	0	0	1 (3%)	1 (1%)
Northern Flying Squirrel (*Glaucomys sabrinus*)	0	0	1 (<1%)	1 (<1%)
Red Squirrel (*Tamiasciurus hudsonicus*)	5 (5%)	1 (1%)	3 (2%)	9 (3%)
Snowshoe Hare (*Lepus americanus*)	12 (95 %)	15 (99%)	20 (95%)	47 (96%)
White-tailed deer [2] (*Odocoileus virginianus*)	0	2	0	2

[1] = Biomass estimated based on the following estimates of prey body mass (Wilson and Ruff 1999): northern flying squirrel (108 g), red squirrel (195 g), grouse (900 g), and snowshoe hare (1400 g).
[2] = White-tailed deer excluded from biomass calculation; only consumed by a single individual.

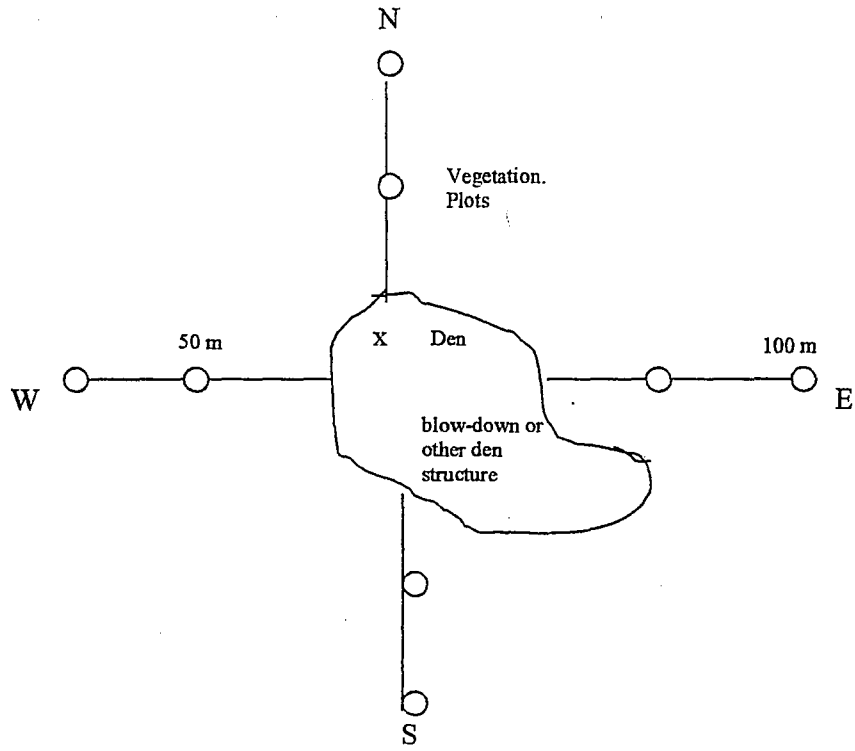

Figure 1. Configuration of vegetation plots that were used to quantify habitat characteristics of forest stands at lynx den sites.

Table 10. Sampling intensity of adult lynx monitored in northwestern Montana in terms of winter tracks and telemetry relocations, February 1998 - August 2001.

Lynx	Winter Tracks – 1999-00	Winter Tracks – 2000-01	Total Winter Tracks	Summer Relocations	Summer Relocations with Sampled Plots [1]	Status
			SEELEY LAKE			
F01	5	7	12	65	29	mortality
F10	6	6	12	82	28	current
F14	4	8	12	89	30	mortality
F18	6	0	6	39	24	mortality
F38	n/s [2]	n/s	n/s	4	0	mortality
F40	0	12	12	48	29	current
F51	n/s	n/s	n/s	8	0	lost
F55	n/s	11	11	13	0	lost
F70	n/s	n/s	n/s	34	9	new capture[3]
M02	5	6	11	54	15	mortality
M04	4	7	11	70	37	current
M05	3	0	3	48	32	mortality
M06	4	0	4	71	38	lost
M07	4	7	11	49	33	current
M20	0	0	0	16	0	mortality
M26	4	7	11	47	27	current
M28	0	0	0	27	14	lost
M32	2	9	11	36	22	current
M36	n/s	n/s	n/s	9	0	lost (mortality, see Table 6)
M54	n/s	n/s	n/s	12	0	current
			GREAT BEAR WILDERNESS			
F64	n/s	n/s	n/s	15	3	current
F65	n/s	n/s	n/s	1	0	mortality
M61	n/s	n/s	n/s	13	3	current
M62	n/s	n/s	n/s	14	4	current
M63	n/s	n/s	n/s	9	0	mortality

Table 10. cont.

Lynx	Winter Tracks – 1999-00	Winter Tracks – 2000-01	Total Winter Tracks	Summer Relocations	Summer Relocations with Sampled Plots [1]	Status
			LINCOLN			
F52	n/a	n/a	n/a	34	5	new capture
M42	n/s	n/s	n/s	8	6	mortality
M44	n/s	n/s	n/s	7	6	mortality
M46	n/s	n/s	n/s	5	3	lost
M34	n/s	n/s	n/s	36	10	current
M53	n/a	n/a	n/a	36	7	new capture

[1] = The number of summer relocations with habitat plots that have been quantified through ground sampling.
[2] = not sampled (n/s)
[3] = Captured during winter 2000-01.